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CSCanada
Advances in Petroleum Exploration and Development
Vol. 10, No. 2, 2015, pp. 108-110
DOI:10.3968/7579

ISSN 1925-542X [Print]
ISSN 1925-5438 [Online]
www.cscanada.net
www.cscanada.org

Study on Small Layers Producing Condition by Using the Method of Fuzzy Comprehensive Evaluation

SONG Jingyang[a],*; FANG Yanjun[a]; ZHAO Chunsen[a]; WANG Guangjie[a]

[a] Department of Petroleum Engineering, Northeast Petroleum University, Daqing, China.
*Corresponding author.

Supported by Scientific Research Project of the Northeast Petroleum University Graduate Education Innovation Base (YJSJD2015-004NEPU).

Received 25 September 2015; accepted 28 October 2015
Published online 31 December 2015

Abstract
Before the subdivision adjustment of single well layers carried out, we need to evaluate the producing degree of the existing layers. There are many factors affecting the properties of small layers. This paper, using fuzzy comprehensive evaluation method, calculates the comprehensive evaluation coefficient to judge the property of each small layer.

Key words: Fuzzy comprehensive evaluation; Small layer coefficient; Producing condition

Song, J. Y., Fang, Y. J., Zhao, C. S., & Wang, G. J. (2015). Study on small layers producing condition by using the method of fuzzy comprehensive evaluation. *Advances in Petroleum Exploration and Development*, *10*(2), 108-110. Available from: URL: http://www.cscanada.net/index.php/aped/article/view/7579
DOI: http://dx.doi.org/10.3968/7579

INTRODUCTION
In order to enhance the utilization rate of water flooding of the extra-high water cut oil field, small layers of injection wells must be have subdivision adjust, and the evaluation of small layers' producing degree is the necessary theoretical basis before the layers subdivision adjustment. At present, the evaluation method of small layers producing degree is not accurate. This paper expounds the calculation process of fuzzy comprehensive evaluation method. This paper, using comprehensive evaluation coefficient (E1), characterizes small layers producing condition more precisely, and set an example of injection well 18-7 to demonstrate the application of fuzzy comprehensive evaluation method.

1. AHP ANALYSIS TO DETERMINE THE EVALUATION INDEX-WEIGHT
We considered the effect of five factors as evaluation index of small layers producing condition. There are water cut of oil Wells (FW), recovery degree (RD), water injection intensity (WII), oil production intensity (OPI), small layers water absorption profile (SWAP).

According to the actual experience and repeated verification, it shows that water cut and recovery degree is extremely important compared with other factors, and it is concluded that the weight of the both accounted for about 80%. So, we determine the judgment matrix P according to their importance in the small layers properties.

$$P=\begin{bmatrix} & \text{SWAP} & \text{WII} & \text{OPI} & \text{RD} & \text{FW} \\ \text{SWAP} & 1 & 1/2 & 1/3 & 1/9 & 1/9 \\ \text{WII} & 2 & 1 & 1/2 & 1/8 & 1/8 \\ \text{OPI} & 3 & 2 & 1 & 1/7 & 1/7 \\ \text{RD} & 9 & 8 & 7 & 1 & 1/2 \\ \text{FW} & 9 & 8 & 7 & 2 & 1 \end{bmatrix}.$$

2. THE BASIC PRINCIPLE OF FUZZY COMPREHENSIVE METHOD
The so-called fuzzy evaluation, is making the overall evaluation to things by utilizing fuzzy relationship principle after considering the various factors related to the judged things. The basic methods and steps are as follows:

(a) Each element Represents various influencing factors which have different degree of fuzziness. There are m samples need be classified, then the sample set are

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available determined by fuzzy matrix which describe the characteristics of things. It is given by:

$$U = (u_{ij})_{n\times m}\ (i = 1, 2,..., n, j = 1, 2,..., m). \quad (1)$$

In order to eliminate the influence of physical units, the paper use the utility function to normalize the characteristic value of the described things, when we do classification calculation.

The bigger the better type of index, the calculation formula of the utility function is:

$$b_{ij} = \frac{u_{ij} - (u_{ij})_{\min}}{(u_{ij})_{\max} - (u_{ij})_{\min}}. \quad (2)$$

(b) The smaller the better type of index, the calculation formula of the utility function is:

$$b_{ij} = 1 - \frac{u_{ij} - (u_{ij})_{\min}}{(u_{ij})_{\max} - (u_{ij})_{\min}}. \quad (3)$$

Thus we get the available utility function matrix B:

$$B = [b_{ij}]_{n\times m}.$$

According to the utility function matrix B by using analytic hierarchy process (AHP) and the weight of each index $W = [W_1, W_2,...,W_n]$, the comprehensive evaluation coefficient value of each sample is:

$$E = \sum_{j=1}^{n} W_j b_{ij}\ . \quad (4)$$

The more comprehensive evaluation coefficient E1, the better producing situation.

3. THE EXAMPLE ANALYSIS

The paper takes the injection well Ba 18-7 for example to analyze each small layer property of the injection well with fuzzy comprehensive evaluation method. The influence factors of each small layer data are shown in Table 1 as below.

Table 1
Various Factors Data of Well Ba18-7 Table

Number	SWAT (%)	WII (m^3/d·m)	OPI (m^3/d·m)	RD (%)	FW (%)
II3-1	0.094	0.308	1.64	0.33	0.929
II3-2	0.047	0.588	2.376	0.237	0.857
II3-2	0.002	0.348	1.058	0.337	0.94
II3-3	0.014	1.579	0.915	0.364	0.923
II4-1	0.188	0.32	0.969	0.288	0.923
II4-2	0.016	1.581	2.373	0.288	0.868
II5-1	0.076	0.727	1.558	0.206	0.715
II5-1	0.147	0.533	0.19	0.282	0.867
II5-1	0.283	0.75	1.64	0.333	0.911
II5-2	0.057	0.632	1.795	0.288	0.903
II5-3	0.076	0.64	0.542	0.395	0.933

According to the above factors, using the utility function Equations (1)-(2), we could calculate the membership degree value (belong to the bigger the better type) of various influence factors which are shown in Table 2.

Table 2
Well Ba 18-7 Membership Data of Various Influencing Factors Table

Number	SWAP	WII	OPI	RD	FW
II3-1	0.031	0	0.289	0.402	0.852
II3-2	0.122	0.035	1	0.67	0.966
II3-2	0	0.005	0.186	0.792	1
II3-3	0.426	0.86	0.161	0.54	0.876
II4-1	0.031	0.002	0.171	0.828	0.98
II4-2	0.049	1	0.418	0.653	0.954
II5-1	0.021	0.053	0.275	0	0
II5-1	0.031	0.028	0	0.642	0.85
II5-1	1	0.056	0.289	0.539	0.936
II5-2	0.015	0.041	0.316	0.745	0.984
II5-3	0.021	0.042	0.096	1	0.959

4. THE DETERMINATION OF SMALL LAYERS PRODUCING CONDITION

By analytic hierarchy process (AHP), we determine weights for the W = [0.051, 0.06, 0.051, 0.06, 0.448]. According to the principle of fuzzy comprehensive evaluation, we make the weight and membership degree into fuzzy transformation, then concludes the comprehensive evaluation coefficient (E1) of each small layer by programming shown in Table 3.

Table 3
Small Layers of Well Ba 18-7 Comprehensive Evaluation Coefficient Table

Number	Comprehensive evaluation coefficient (E1)
II3-1	0.706
II3-2	0.741
II3-2	0.598
II3-3	0.755
II4-1	0.7
II4-2	0.682
II5-1	0.403
II5-1	0.631
II5-1	0.727
II5-2	0.688
II5-3	0.844

From Table 1 to 3 we could found that with the increasing of E1, the influence factors of the small layers of well Ba 18-7 has increasing trend as a whole, small layers has better producing condition. Thus, the value of E1 which is calculated by using the fuzzy comprehensive evaluation method can better reflect the producing condition of each small layer.

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CONCLUSION

(a) We determine the value of the weight of each influence factor by using the analytic hierarchy process (AHP) and combined with actual experience.

(b) The paper calculate comprehensive evaluation coefficient (E1) which reflects the producing condition of small layers by using fuzzy comprehensive evaluation method, and then judge the producing degree of small layer.

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